

DUNE Near Detector Overview

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Goals of the DUNE Near-Detector

(A) Constrain the systematic uncertainties in the Oscillation Measurements/Searches

⇒ Neutrino Source: ν_μ , ν_e , $\text{anti-}\nu_\mu$, $\text{anti-}\nu_e$ in

“PMNS-Oscillation $\Rightarrow 0.5 \leq E_\nu \leq 10 \text{ GeV}$ ” & “Control & New-Physics $\Rightarrow 10 \leq E_\nu \leq 50 \text{ GeV}$ ” regions

⇒ Neutrino and Antineutrino Energy-Scale / Topologies

⇒ Characterize Signal & Backgrounds to the oscillation signals: $\pi^0/\pi^-/\pi^+$

(B) A generational advance in the Precision Neutrino Physics

⇒ Cross-sections: QE, Resonance, Coherent-Meson, DIS, Neutral Currents, ..

⇒ Neutrino-Nucleus (Ar) interactions & Nucleon Structure

⇒ Electroweak and Isospin Physics

(C) Search for New Physics

⇒ Heavy neutrinos, including ‘Light Dark-Matter’ search

⇒ Large Δm^2 oscillation

⇒ ...

The *ND Requirement* document

- **ND Req. (Glo-Sci-41)* \Rightarrow ND measurements shall be of **sufficient precision** that when extrapolated to predict the FD event spectra without oscillations, the **associated systematic error must be significantly less than the FD statistical error** over the lifetime of the experiment.
- **ND-Req. (Glo-Sci-51 & 23)* \Rightarrow ND shall measure $\nu\mu$, $\bar{\nu}\mu$, $\nu e \oplus \bar{\nu}e$ events
- **ND-Req. (Glo-Sci-51 & 23)* \Rightarrow ND shall measure **absolute & relative** (FD/ND) flux
- **ND-Req. (Glo-Sci-54)* \Rightarrow ND shall measure **ν -Ar** interactions
- **ND-Req (Glo-Sci-53)* \Rightarrow ND shall measure **rates, kinematics, and topologies** of various processes (**QE, Res, DIS, ..**)
- **ND-Req (Glo-Sci-52)* \Rightarrow ND shall measure **NC & CC cross-sections** as a function of visible-energy
- **ND-Req (Glo-Sci-24)* \Rightarrow ND shall measure **backgrounds to Osci.-signal**

Three Near Detector Options:

(1) **Fine Grained Tracker (FGT): Reference detector** for CDR, and the Independent design (May/15), Director's (Jun/15) & CD1 (Jul/15) Reviews

⇒ STT R&D (Talk by Vipin/Arvinder)

⇒ ECAL R&D (Talk by Bipul)

⇒ Optimization: Nuclear Targets (Ar, Ca, C, etc.) (Talk by Roberto)

(2) **Liquid Argon (LAr) Option:** Augment the FGT design
(TBD; Martin/Antonio @ next meeting)

(3) **High Pressure Ar-Gas (HP-ArGas) Option:**
(Talk by George)

⇒ Detector-Physics Group: *A very large overlap* with the **ND-Physics Group**

Minimal set of Questions for any given ND-Option

- (1) Sensitivity (precision) to the *absolute flux* measurement of $\nu_\mu \leftarrow \nu\text{-Source}$
- (2) * Precision on the un-oscillated Relative-Flux, $FD/ND(E\nu)$, for ν_μ , $\nu_\mu \leftarrow \nu\text{-Source}$
- (3) Precision on the predicted ν_e/ν_μ (ν_e/ν_μ) at the FD \leftarrow *Signal*
Efficiency and Purity of π^0 from NC .&. CC \leftarrow *Background*
- (4) * Efficiency and Purity for $\nu_e\text{-CC}$ ($\nu_e\text{-CC}$) \leftarrow *Interaction model*
- (5) * Efficiency and Purity for ν_μ -induced QE and *Resonance* (Δ^{++}) \leftarrow *Interaction model*
- (6) * Error on the *energy-scale* of Neutrino & Anti-Neutrino \leftarrow *Interaction model*
 \Leftrightarrow *in situ constraints on the initial and final state interactions in Ar*

ND \Rightarrow *FD*: Quantify how to 'translate' ND-measurements to FD: